

NO.27 FEBRUARY 1997

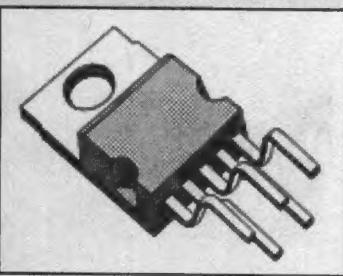
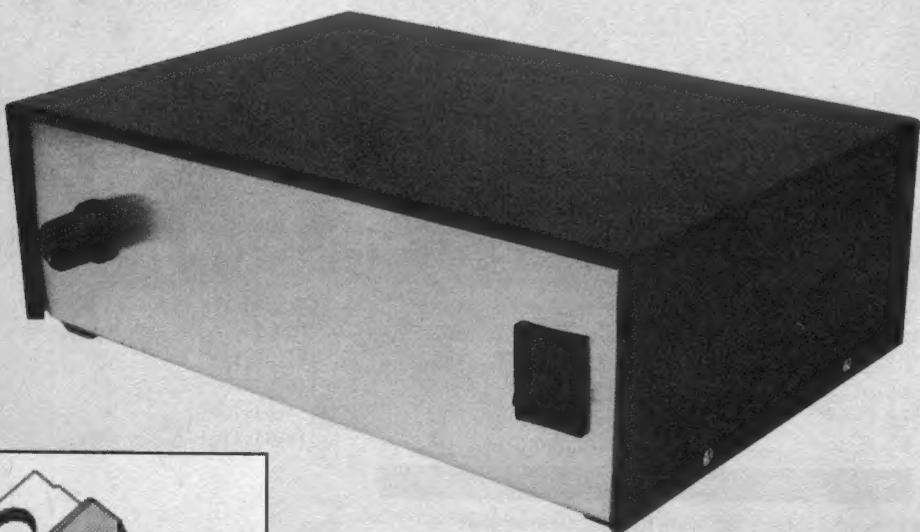
SUPPLEMENT

# 30watts/ch. FOR £60? BUILD A GREAT CHIP AMP!



**SGS-THOMSON**  
MICROELECTRONICS

**TDA2050**  
32W Hi-Fi POWER AMPLIFIER



**(beginners will love this)**

**FREE D.I.Y. SUPPLEMENT No. 27**

**BOOK REVIEWS:**

**ACOUSTICS AND  
PSYCHOACOUSTICS**  
by Howard & Angus

**AUDIO POWER AMP.  
DESIGN HANDBOOK**

by Douglas Self

**Audio Power  
Amplifier Design  
Handbook**

DOUGLAS SELF



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KT66	68	KT88	86	8550C	22	807	8	311	18	312	28
813	28	815	22	808	30	12E1	14	1LE12	36	1SE1	90
8L8G	12	7581A	15	7504	38	DA41	14	DA12	14	DA100	675
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ECC33	20	ECC34	18	ECC35	18	M8137	22	CV4003	12	CV4004	14
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0.05 µF	600	£1.68	0.006 µF	1000	£0.77	220 pF	500	£1.88	220 µF	400	£18.40
0.1 µF	600	£2.17	1.0 µF	600	£2.18	470 pF	500	£2.10	470 µF	400	£20.18
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Note! This Capacitor comes in Aluminium Can only. Dic 65 m/m Len 95 m/m. This Capacitor is of superior quality to anything else available and has been designed by us for use in Tube Power Supplies.

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Tube	Impedance	Taps	Sec Ohms	DC m/2	Watts	Type	Dimensions	Price £ Each
300B	2K5		4-6-16	90	8	SE	114x95x110	105
211/VT4C	9K2		4-8-18	60	20	SE	114x95x135	128
845	11K		4-8-16	80	30	SE	114x95x135	144
KT66	4K5		4-8-16	68	5.8	SE	114x95x100	95
KT88	5K	40%	4-8-16	90	50	P/P	114x95x110	108

## CHASSIS

All chassis are made from solid copper 2m/m thick with welded corners and 5m/m flange for bottom plate

Sizes	L	D	H	Price £ each	L	D	H	Price £ each	L	D	H	Price £ each
	330x	200x	75	98	400x	250x	75	128	450x	350x	85	180

## RADIO DESIGNERS HANDBOOK

We have re-printed the famous Langford-Smith Radio Designers Handbook 4th edition. We have only a few copies at £80 per 2 volume set. Bound in black imitation leather gold block A4 size, weight 4.8 kilo's. Only 18 copies left.

## TERMS OF TRADE

All prices quoted are FOB UK. Delivery on some items is 10 to 14 days. Payment can be made by credit card, Cheque, or Telegraphic Transfer. Tubes are warranted as working 100% but not there visual appearance. Minimum order value £100, all prices quoted exclude delivery and VAT at the prevailing rate.

## KIT NEWS

From transformers to tweeters, you'll find some rare but valuable hi-fi bits in this section.

5

## 30 watt SILICON CHIP AMPLIFIER

This has got to be the greatest way to build your first amplifier. Dead simple but very effective. Great for beginners, the impoverished, students and audio addicts everywhere.

7

## TUNING WITH SPECIAL COMPONENTS

What'sa Black Gate? You mean to tell us you don't know? It's somfing black sheep go through. If you believe this, then you need to read this feature to protect your audio cred. Or jump off a cliff in shame.

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## BOOK REVIEW:

### ACOUSTICS AND PSYCHOACOUSTICS

by Howard and Angus

A goodly sized tome covering sound, room acoustics, human hearing mechanisms and perceptual strategies, plus electronic sound processing. Reviewed by Noel Keywood.

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### AUDIO POWER AMPLIFIER DESIGN HANDBOOK

By controversial but experienced designer Douglas Self, this book is backed by solid practical experience, available research and Self's interest in producing the 'perfect' amplifier. Reviewed by another designer of great experience and knowledge, Andy Grove.

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## DIY QUERIES

Loads-a-Queries from our DIY swagbag. This is where the discussions are technical, esoteric - and interesting! Yes, lots of in-depth info on what makes a good hi-fi design.

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# KIT NEWS

## MISSING LINK

The latest audiophile catalogue from Audio-Links of Scunthorpe is now available. Priced at £2, it contains high quality resistors (running from Vishay bulk foils through to Holco's 0.5% H8 series), capacitors (Ansar Supersound and Silversound, Hovland Musicaps, Elna Cerafines and Panasonic Os-cons) and potentiometers (Alps Blue and Black Beauty as well as Panasonic).

There's also a range of switches, connectors (including gold-plated cartridge tags) and interconnects in addition to loudspeaker and mains cables. The bullion brigade get a look in with pure silver wire, from 36gauge to 14gauge, and matching silver-loaded solder.

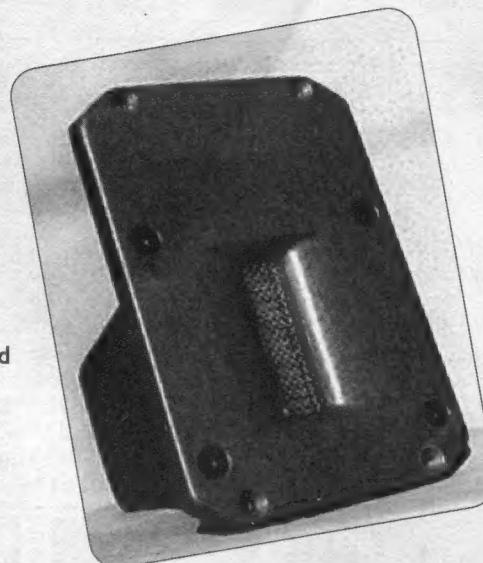


Transistor fans will be happy to find Schottky and soft-recovery diodes, voltage regulators and low noise toroidal transformers as well.

**Audio-Links**  
7 Fairmont Cresc.,  
Scunthorpe,  
North Lincs.  
DN16 1EL  
Tel: 01724 870432

## RIBBON SINGS THE HIGHS

If dome tweeters fail to bring a smile to your face and ribbon tweeters are more your cup of tea, there's now one more to choose from with the arrival of the HRL-1s from Howard Dawson Audio. These are built around powerful ALCOMAX-3 magnets and an extremely



lightweight ribbon to maximise the driver's efficiency (90dB), speed and accuracy.

Given the fact that a pair of HRL-1s will set you back £300, replacing the ribbon element itself is reassuringly cheap (£10) and easy - owners can even make new ribbons themselves, according to Howard Dawson. And almost any impedance can be specified because the HRL-1's matching transformers are interchangeable.

**Howard Dawson Audio**  
16 Copeman Road,  
Aylsham,  
Norwich NR11 6JL

## ITALIAN TRANSFORMATION

If you're having a hard time making up your mind as to what output transformer to buy for that killer valve amp you've been slaving over, Bartolucci can help you out. This Italian company offers over 60 different output transformers to suit a range of valves. Power handling is between 10W and 50W for transformers aimed at single-ended amps, while push-pull versions run from 8W up to a healthy 140W.

All the above transformers are multiple section, multiple layer designs, hand-wound for accurate interleaving and correct wire tension. They come potted with micro-crystalline wax in a hand-made steel enclosure, with output taps that allow matching to 'speakers of

4, 8 and 16 ohms impedance.

Further broadening Bartolucci's brochure is a step-up transformer for MC cartridges as well as interstage coupling and pre-amp output transformers.

Helping out in the power supply department is a range of chokes, running from 10H at 400mA up to 150H at 50mA.

**Audio Marketing**  
Via del Meridiano 38,  
Domagnano,  
47031 San Marino  
Tel: (378) 906634

## WHAT, MORE TRANSFORMERS?

SJS Electroacoustics are expanding their transformer goodie bag and now offer five interstage transformers (with prices from £149 to £189/pr) to complement their pre and power output transformers. Fans of single-ended will

be happy to see



they're offered not only the Standard and Super range (with its superior windings) but also five 'state of the art' transformers. These all employ very complex winding techniques and high purity Oxygen Free Copper with PTFE-insulated, pure silver flying leads, and are potted in non-magnetic cases.

Occupying the catalogue's other pages are power supply chokes and capacitors (custom polypropylenes, Black Gates, Mallorys, Spragues and Hovland Musicaps), Holco H2 1W 1% resistors and silver cable.

**SJS Electroacoustics**  
Ben-Dor,  
Lumb Carr Road,  
Holcombe,  
Lancs. BL8 4NN  
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Long known as specialists in rare tube brands, Billington Export provides a line of premium-grade valves to fill the increasing demand for hard-to-find tubes! BILLINGTON GOLD features specially tested valves selected for long life, low microphony and low noise. Versions with gold plated pins are available. BILLINGTON GOLD brand comes from a variety of countries around the world. We have carefully chosen the best manufacturer for each type, with an emphasis on the highest audio quality and product reliability. We stock one million valves including: BRIMAR, GE USA, GEC UK, MAZDA, MULLARD, RCA, RUSSIAN/SOVTEK/SVETLANA, SYLVANIA, TESLA, THERMIONIC, TUNGSRAM and other rare brands, as well as sockets and CRTs.

### BILLINGTON GOLD

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845	33.00
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E81CC	5.25
E81CC-01	9.50
E82CC	4.50
E82CC-01	8.50
E83CC-01	8.50
E88CC	7.50
ECC81	5.25
ECC82	4.50
ECC83	5.25
ECC88	4.50
EL34	9.95
EL84	3.60
KT66	9.50
KT88	18.50

### RARE BRANDS

5R4GY RCA	POA	6550A GE USA	42.00
5Y3GT RCA	2.90	CV4004 Brimar UK	POA
6BH6 RCA	2.48	DG7-32 Tungsram Hungary	21.00
6CG7 Yugoslavian	6.75	ECC81 Mullard UK (CV4024)	7.50
6V6GT STC UK	5.93	ECC82 Mullard UK (CV4003)	POA
6X4W Raytheon USA	3.00	ECC83/ECC803S Tesla	13.13
6336A	66.00	ECC83 Yugoslavian	2.93
12BH7 Yugoslavian	6.90	ECC85 Tungsram	3.45
12BH7A GE	15.00	ECC86 Tungsram	3.45
12E1 STC/ITT UK	15.00	EF86 GEC UK (CV4085)	19.50
13E1 STC UK	120.00	GZ32 Mazda	9.00
85A2 Mullard	4.50	GZ37/CV378 Mullard UK	5.93
807 USA	8.20	KT90 Yugoslavian	24.00
5687 Sylvania	6.45	PL519 Tungsram	8.40

### SOVTEK

5U4G	3.60	ECC83/12AX7WB	3.75
6L6WGC	6.30	EF86	POA
6SL7GT	2.50	EL34G	6.20
5881/6L6WGC	6.30	EL84	1.99

### RUSSIAN/SVETLANA

6550B-2	18.00
6B4G	19.50
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Try us for ALL Russian/Svetlana valves.

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6SN7GT Russian	3.30
5814A ECG PHILIPS	2.70
6350	1.35
6550B3 Russian Zirconium	16.43
7119/E182CC Mullard USA	9.45
7868 (discount for quantity)	23.63
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Jumbo 4-Pin for 211, 845, etc	10.50
Jumbo 4-Pin, Gold Plated, for 211	13.50
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B5 UK	POA
UX5 McMurdo UK for 807	3.60
B7A for 6C33CB	3.23
B7G McMurdo UK, chassis, skirted	0.72
813 ceramic	7.50
Octal McMurdo UK	1.20
Octal PCB, foreign	1.20
B9A Ceramic, skirted, chassis, screening can; Russian	0.90
B9A PCB, gold pins	1.88
B9D Magnoval, chassis, for PL519	1.80
TOPCAP for 2C34, 807, etc	1.20
TOPCAP for 12E1, 5B-254M, PL519	2.93
MATCHED TESTING	£2.00 per valve (£4.00 per pair)

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MINIMUM ORDER: UK £50.00 + VAT & Carriage. Export £100.00 (US\$150.00) + Carriage.

3,000 OTHER TYPES OF VALVES IN STOCK! PLEASE INQUIRE FOR ANY TYPE NOT LISTED.

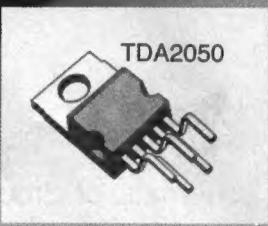
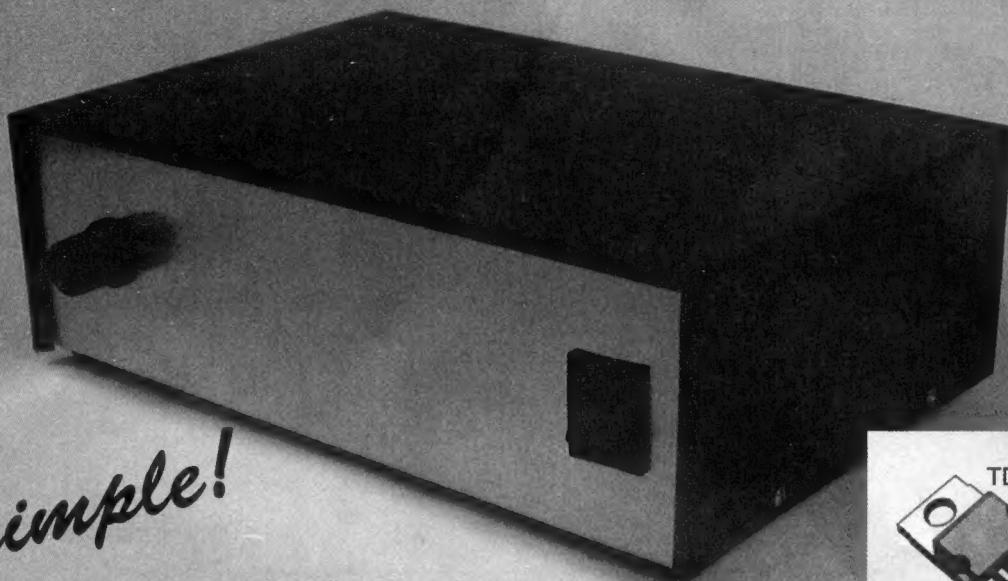
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VISITORS STRICTLY BY APPOINTMENT PLEASE

# YOUR FIRST DIY AMPLIFIER

*It's simple!*



**Want to build your first amplifier? The simplest way is to use a dedicated silicon chip. The components shouldn't amount to more than £60 and there are no naughty voltages. Chris Found explains, step-by-step.**

**T**TV set manufacturers are just one example of those who use one-piece amplifiers on a silicon chip. There are plenty to choose from. These amplifier modules are not in the High End league but they certainly fulfill basic requirements well, giving lots of Watts per Pound.

For a student with very little money or someone who is just starting a course in electronics and needs to gather firsthand knowledge of building, these units are an ideal starting point. To build the units presented in these articles you need to be able to solder components to a board and want to do something you might never have done before.

When I looked at the data sheets, today's sophisticated chip amps look like an amazing bargain. We chose one that is easy to obtain, has been honed through usage and is, technically, easy to understand as well. It is the

SGS Thomson TDA2050. A stereo amp. needs two of them, amounting to no more than £12. However, the mains transformer can cost up to £15, electrolytic capacitors £8 or so and a chassis / heatsink any price you choose. So it's impossible to put an exact price on this amp, but £60 should do it easily.

## The SGS-THOMSON



TDA2050

32W Hi-Fi AUDIO POWER AMPLIFIER

- HIGH OUTPUT POWER (50W MUSIC POWER IEC 268.3 RULES)
- HIGH OPERATING SUPPLY VOLTAGE (50V)
- SINGLE OR SPLIT SUPPLY OPERATIONS
- VERY LOW DISTORTION
- SHORT CIRCUIT PROTECTION (OUT TO GND)
- THERMAL SHUTDOWN

The TDA 2050 is a monolithic integrated circuit in Pentawatt package, intended for use as an audio class AB audio amplifier. Thanks to its high power capability the TDA2050 is able to provide up to 35W true rms power into 4 ohm load and up to 32W into an 8ohm load.



Pentawatt

## TDA2050

The TDA2050 is an Integrated Power I.C. built into what is normally called a Pentawatt package, in other

words a TO220 transistor with five legs instead of three. Bear the package type in mind when selecting a heatsink.

It is capable of working on single or simple split rail power supplies. The split rail supply option is especially useful because it eliminates the output coupling capacitor, and its degradation of sound quality.

The 2050 can produce

rail of +/- 22V.

You might feel that 10% distortion is just a tad excessive, but it is merely a way of defining overload and maximum output. For most music applications such as an audio stage in a TV set, the distortion will be substantially lower than this, as our measured performance figures show. Performance is very good indeed for its low price and this chip is both robust and reliable - almost bombproof in fact.

Sophisticated circuit protection has been applied, as well as thermal limiting. This makes the TDA2050 an extremely reliable product for any manufacturer, but also for the DIYer.

Looking at the 2050's operational schematic diagram (Fig 1, p8) shows just how simple the unit is to construct. Just eight components per channel are needed, plus decoupling and power supply components. Providing you are careful

some 35watts into a 4Ω load (the limit being defined by 10% distortion) when using a supply of +/-18volts, or 32watts into 8Ω with a supply

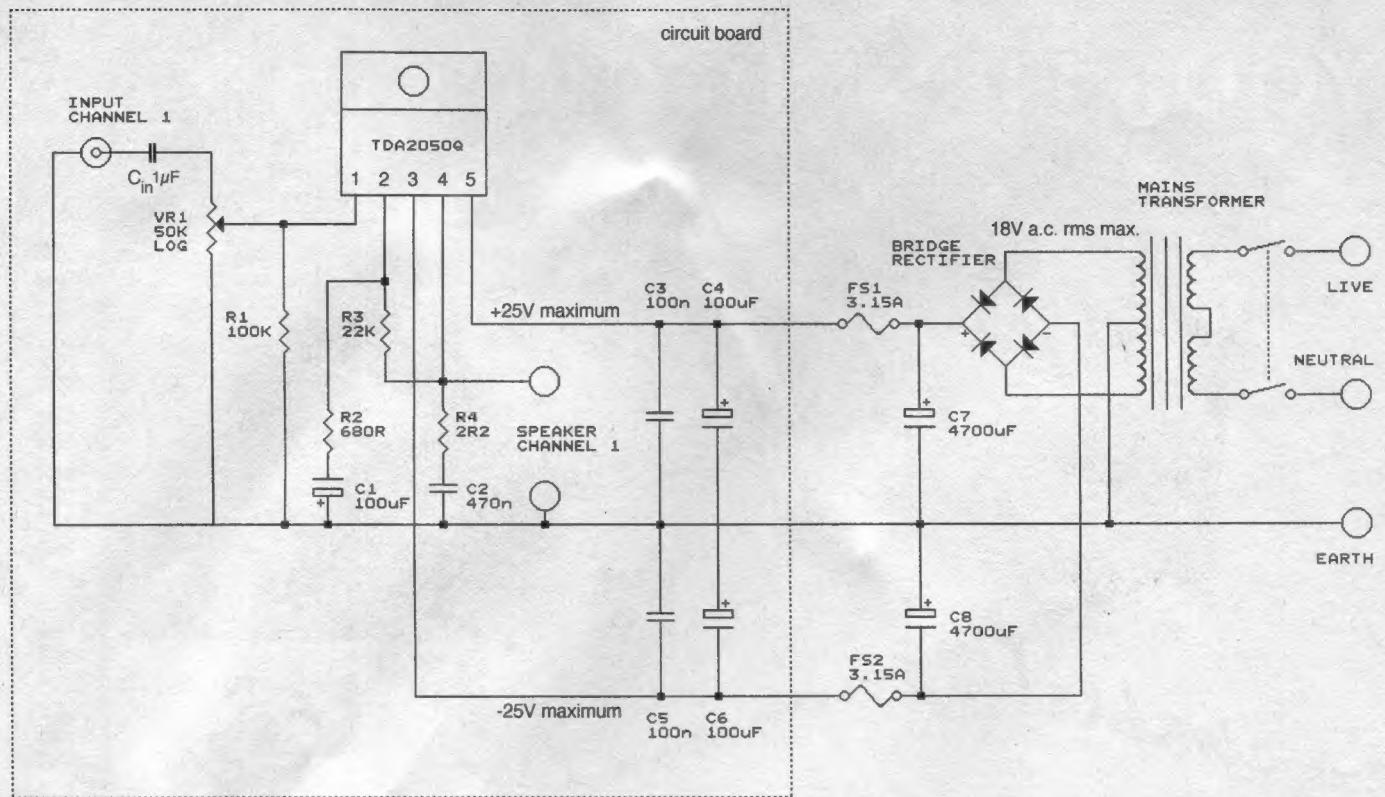


Fig 1 - Schematic of circuit

## How the circuit works.....

The signal is fed in through  $C_{in}$ , which acts as a d.c. blocking capacitor. This should be left in for safety, since residual d.c. exists on many sources. Remove it if working from a preamp with an output blocking capacitor. Feeding d.c. in will otherwise produce d.c. on the output, which will offset the 'speaker cones'.

RI holds the non-inverting (+) input to ground with respect to d.c. conditions, should the volume control fail to do so. CI/VR1 form a high pass filter with a -3dB point around 4Hz. Lower Cin to 0.47µF and this rises to around 8Hz, which is where most designers choose to put the lower limit.

Feedback, both a.c. and d.c., is applied from output back to the inverting (-) input through resistor R3, set at 22k. Altering this resistor changes the amount of feedback applied, R3/R2 acting as a potential divider with respect to the a.c. (audio) signal being fed back. Reducing R3 increases the amount of feedback applied. This will increase bandwidth, decrease distortion and reduce gain. Go too far and the circuit will oscillate (i.e. become unstable). Increasing R3 will improve stability and raise gain, but increase distortion and lower bandwidth. Capacitor C2 ensures 100% d.c. feedback is applied. Ideally, this capacitor should comprise two back-to-back tantalums of 50 $\mu$ F-200 $\mu$ F, in order to produce a non-polarised capacitor.

Components R4 and C2 ensure high frequency stability. Capacitors C3 and C5 ensure power line decoupling is effective at high frequencies. These should be good quality polypropylenes. The chip has both short circuit protection and thermal shut down, so it's rugged.

The chip is designed to accept 25V maximum on its supply rails. We recommend using a mains transformer of 15V a.c. rms, but an 18V a.c. transformer can be used, which will give 23V-24V, taking into account regulation, bridge rectifier losses, etc. A rating of 50VA minimum should be used. Bigger VA ratings give better regulation and stronger bass. Chris Found lists Maplin's DH63T, which has two 15V secondaries, one 240V primary, is rated at 4A and 120VA and costs £18. Cricklewood Electronics (0181-450-0995, 40 Cricklewood Broadway, London NW2 3ET) is where we bought our parts and they can help too. NK

(more so, if you are a first time builder), you should be able to get this unit up and running in no time at all.

I decided to build the prototype amplifier on two separate pieces of 0.1" copper clad Veroboard. It allows the amplifier to be built in easy stages, replacement of one part is made easier, servicing is easier and Veroboard is best when circuits are kept small and simple. Large Veroboard constructions are prone to

problematic mix-ups. Our Veroboard layout is very simple and providing basic procedures are adhered to, the units should work straight away.

## FIRST TIME

The following list should be used when constructing anything for the first time. It safeguards not only your hard earned money but also ensures that you do not die in the attempt of building your first unit.

Build each board slowly and follow the drawings very carefully, checking every solder joint, component position and the polarity of the components. If necessary redraw the layout on a separate sheet with all the positions and their polarities.

Where mains voltages are concerned, use sleeved 'crimp on' spade terminals for the mains switch and the IEC mains connector. You can get these from any car spares shop and they are very cheap.

Also use only the appropriate wire suitable for the job in hand. Do not use wire too thin for the mains linking, as this could overheat and cause a fire if left on for an appreciable amount of time.

Triple check everything in accordance to the information given. If you are unsure, ask a local repair shop or a knowledgeable friend to look over the unit. It may cost you a few quid but it's worth it.

#### Make a final check against

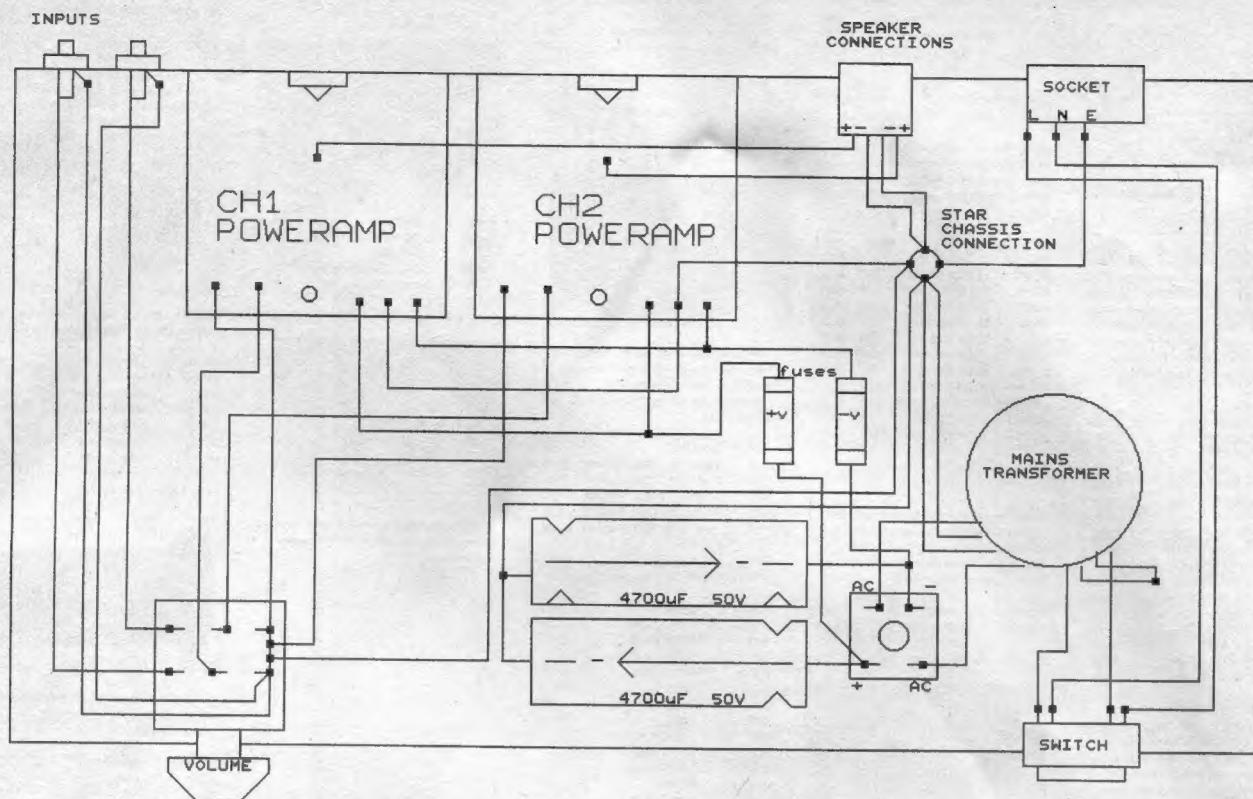


Fig 2 - Amplifier layout

all of the drawings, ensuring the areas that require isolation, i.e. the heat sink and the tab on the devices, are electrically isolated from the chassis but thermally connected using the proper heat sink compound, thereby allowing heat to be dissipated effectively.

When you power up the unit for the first time, do not

mind that the large reservoir capacitors used need time to discharge.

*Always remember, anything connected to the Mains supply is potentially dangerous.*

**MAINS VOLTAGES CAN KILL.** Use extreme care and follow all instructions to the letter.

If you have a multimeter check the various test points for their

iron, not the Weller Arc welding type  
Spanners if you can borrow some

### CONSTRUCTION

Cut a small piece of Veroboard 17 strips wide and 17 holes long and clean off the rough edges with a small flat file. Fig. 3 shows the placement of the components for each of the two pieces of Veroboard. You will notice that these two boards are identical. The remaining power supply components are hardwired. Each piece of Veroboard comes pre-drilled as standard with copper tracking strips to allow components to be placed in certain positions. I normally remove all the unwanted tracking to prevent shorts when soldering and put Vero terminal pins in the positions that require wire to be soldered to the boards.

On each of the two amplifier boards the TDA2050 is mounted as close to the far end of the board as possible, track side down. The TDA2050 chip connection pins go through

the opposite side of the board. The metal tab of the 2050 is secured to the inside wall of the case and the optional outside heat sink.

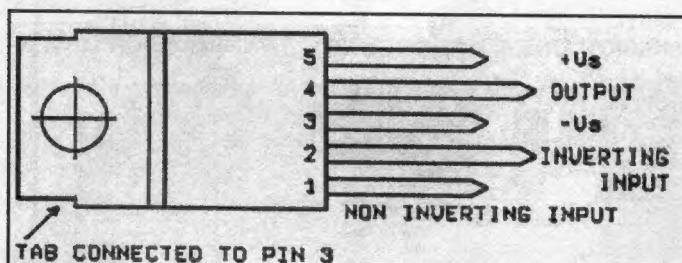
To ensure the board stays rigid and cannot short to the metal case a plastic spacer is mounted at the opposite end to provide support. It helps when wiring up the boards later.

Construction of the power supply section is very simple. I used a large chassis-mounting bridge rectifier, which is marked on its body +, -, AC, AC.

### WIRING THE POWER SUPPLY

First, mount the bridge rectifier to the case using an M3 screw and nut. Next, connect the spade connectors to the secondary wires of the mains transformer then push them onto the AC terminals of the bridge rectifier. They go on either way around; there is no polarity to be observed.

Fix the reservoir capacitors to the chassis, either with a clamp or using glue. Solder the positive wire of one reservoir capacitor to



connect any speakers to the output terminals. Do not connect an input signal either. Instead very carefully look and smell for burning, but do not get too close just in case there is something wrong. Wear some protection for your eyes if you need to look closer than a few feet. Leave on for only two minutes and then switch off and leave the unit to cool down for at least 15 minutes. Please bear in

correct D.C. voltages on the second test.

### TOOLS

The following tools are required to build the amplifier.

Small wire cutters  
Small and medium size pliers  
Various screwdrivers  
Files  
Electric or Hand drill with assorted drill bits  
15 or 25W small soldering



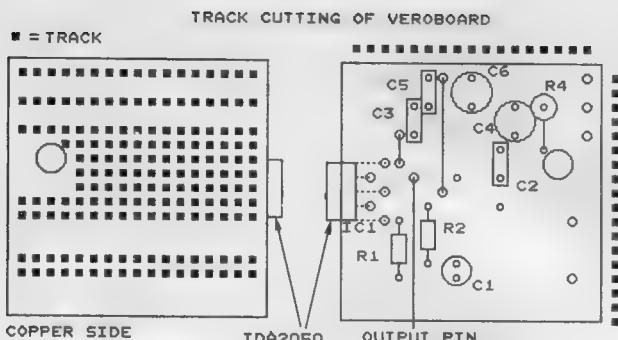


Fig 3 Amp board layout

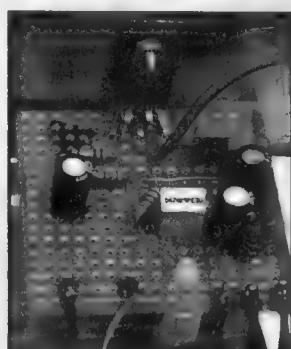
the + connection of the bridge rectifier. Do the same for the negative wire from the second capacitor, taking it to negative on the bridge rectifier. Solder the free positive and negative capacitor terminals together and take them to the star earth through another wire. See Fig 2.

The bridge rectifier converts the AC voltage from the mains transformer into a DC voltage that powers the chip. The two reservoir capacitors hold the voltage stable during high signal levels, smooth out hum and ensure that the amplifiers do not effectively run out of steam.

## BUILDING THE BOARDS

Mount the smallest components first. These are the resistors which are colour coded in accordance to the value and tolerance of the component. In the parts listing, the colour code

sequence for each resistor is described, so that you can familiarise yourself with this coding. You will notice that R4 is mounted vertically.



Once the resistors are in place, you can now see where the tracks need cutting, with a specialist Veroboard cutter or a 3.5 - 4mm drill. Do not cut into the board too hard or it will break or the hole will be too big. Cut just enough to remove the copper.

Mount and solder the terminal pins to the board

now, to save any damage later. These pins can sometimes be very stiff to put in the holes. Use either the special Veropin tool or a small pair of pliers on the edge of a hard surface, say a piece of wood.

Next mount the capacitors. All have their values and working voltages printed on the side of the part.

Make sure the electrolytic capacitors are fitted the right way round. The bar or dashed line usually corresponds to the negative terminal of the capacitor.

The low value polyester capacitors (the ones without a polarity marking) are non-polar and can be placed any way round without the need to observe the polarity.

Finally fit the TDA2050, making sure not to bend the pre-formed legs too far from their original position as they are quite fragile. They should easily fit into the 0.1" pitch of the Veroboard. Having built the first power amplifier board triple check everything and when you are sure that the board matches the drawing, use it as the reference for the next one.

## BUILDING THE CASE

The case is purchased undrilled. Our photograph shows how the prototype

was constructed. Drill the holes to accommodate the volume control and mains switch on the front panel. Drill the holes for the back panel second and, lastly, the holes on the underside of the case.

To form the square hole needed for the push-fit mains switch, measure the switch and mark the square hole with a felt

pen. With an electric or hand drill use a 3mm drill bit to start the hole in the centre. Enlarge it with a 10mm drill bit, then with a small round file enlarge this hole until it is as close to the switch outline as possible. Use a small flat file to put in squared corners.

Use the same procedure for the Mains IEC socket on the rear of the case. This socket should be mounted in line with the switch on the rear of the case, so that you use the minimum amount of wire to connect these two parts together. The fixing holes for the socket are normally M3 (Metric 3mm).

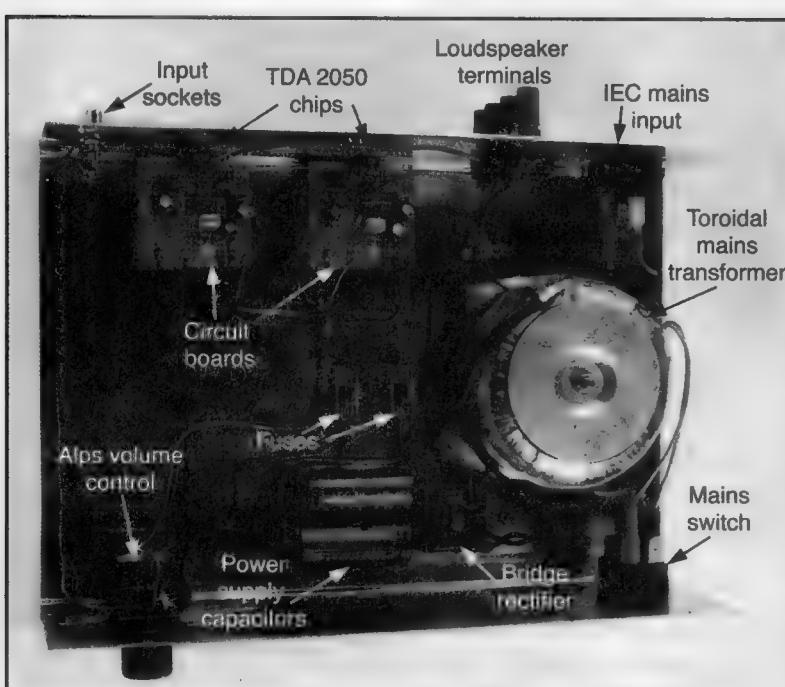
Place the mains transformer inside the case on the switch side. Leaving 15-20mm gap from the side of the case mark the centre of the transformer and drill the M4 / M5 hole required for the mounting bolt. Do not fit the mains transformer yet.

Look on the mains transformer body and follow the instructions to connect it to the mains supply.

Fit sleeved spade connectors to the transformer primary leads, carefully cleaning the ends of the wires with a sharp blade just in case they are dirty. Make sure to crimp the connectors properly with a pair of pliers, so as to make the best connection and finish this area by making up the lead that links between the switch and the IEC socket.

Check the connections to the switch with Fig 2, to make sure that these connections do not short the mains when the switch is activated. Fig 2 shows the normal connections for a standard double pole rocker type switch.

Finally connect the earth wire and secure one end to the case, using a solder tag and an M3 screw and nut to firmly fit it to the case. You can now fit the mains transformer to the case, using the supplied hardware. Lightly tighten the fixing bolt, but not too tight.



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Hart Audio Kits and factory assembled units use the unique combination of circuit designs by the renowned John Linsley Hood, the very best audiophile components, and our own engineering expertise, to give you unbeatable performance and unbelievable value for money.

We have always led the field for easy home construction to professional standards, even in the sixties we were using easily assembled printed circuits when Heathkit in America were still using tagboards! Many years of experience and innovation, going back to the early Dinsdale and Bailey classics gives us incomparable design background in the needs of the home constructor. This simply means that building a Hart kit is a real pleasure, resulting in a piece of equipment that not only saves you money but you will be proud to own.

Why not buy the reprints and construction manual for the kit you are interested in to see how easy it is to build your own equipment the HART way. The FULL cost can be credited against your subsequent kit purchase.

## 'AUDIO DESIGN' 80 WATT POWER AMPLIFIER.

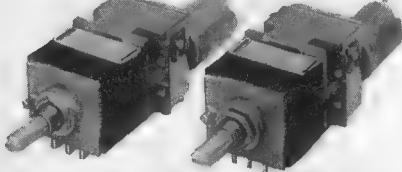


This fantastic John Linsley Hood designed amplifier is the flagship of our range, and the ideal powerhouse for your ultimate hi fi system. This kit is your way to get £K performance at bargain basement prices. Unique design features such as fully FET stabilised power supplies give this amplifier World Class performance with startling clarity and transparency of sound, allied to the famous HART quality components and ease of construction. Standard model comes with a versatile passive front-end giving switched inputs, with ALPS precision 'Blue Velvet' low-noise volume and balance controls, no need for an external preamp. Construction is very simple and enjoyable with all the difficult work done for you, even the wiring is pre-terminated, ready for instant use! All versions are available with Standard components or specially selected Super Audiophile components and Gold Plated speaker terminals and all are also available factory assembled.

K1100 Complete STANDARD Stereo Amplifier Kit. . . . . £415.21  
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## ALPS "Blue Velvet" PRECISION AUDIO CONTROLS.



Now you can throw out those noisy ill-matched carbon pots and replace with the famous Hart exclusive ALPS 'Blue Velvet' range components only used selectively in the very top flight of World class amplifiers. The improvement in track accuracy and matching really is incredible giving better tonal balance between channels and rock solid image stability. Motorised versions have 5v DC motor.

**MANUAL POTENTIOMETERS**  
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2-Gang 10K, 50K or 100K Log. . . . . £16.40  
2-Gang 10K Special Balance, zero crosstalk & centre loss. . . . . £17.48

**MOTORISED POTENTIOMETERS**  
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2-Gang 10K RD Special Balance, zero crosstalk and less than 10% loss in centre position. . . . . £26.98

## 32W VALVE AMP TRANSFORMERS

Special set of toroidal transformers, 2 output & 1 mains for the "Hot Audio Power" valve amplifier design described in the Oct. 1995 issue of "Wireless World". Total Wt 4.8Kg. Special price for the set. £99, Post £8. Photocopies of Article by Jeff Macaulay. £2.00

## JOHN LINSLEY HOOD

### SINGLE ENDED CLASS 'A' POWER AMPLIFIER

A new concept in amplifier design to meet the needs of modern users who want the warmth and purity of sound given by valve amplifiers from the vintage years, without the problems of cost, deterioration and danger associated with trying to use valves today. It employs the newly re-discovered single-ended circuit configuration to give total freedom from crossover artifacts and to give a sound that is indistinguishable from the famous 'Williamson' design, the undisputed leader of the field, with its triode connected KT66s and all-triode drivers. Described in the September 1996 issue of EWW the new version retains the basic simplicity and purity of the original but with modern components and an increased power rating of 15W RMS per channel. Full Kit in 3u high Rackmount Case. . . . . £388.25  
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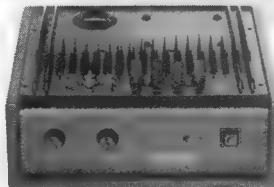
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### ASM100 ACTIVE SUBWOOFER MODULE



This attractive module consists of a low pass filter and power amplifier ready for you to mount in a suitable sub-woofer cabinet. The combined unit can then be combined with any new or existing hi fi or home cinema speaker system to add in the real bass punch missing from most setups.

The ASM 100 module comes as a ready-to-mount unit on a solid diecast aluminium frame/heatsink. Input signal can be at line or speaker level for easy system integration. There are three separate stereo inputs at line level and the unit will use any signal presented or mix all inputs to add bass to any signal. The speaker level inputs are used by simply wiring the unit in parallel with the existing speakers to provide them with strong bass support. Crossover frequency can be selected to 50, 100 or 200Hz and the bass level can be adjusted by a front panel control. The 'Green' power supply switches the unit to standby if no signal is present. Drawings are included free for the compact 418 x 380 x 303mm cabinet. With its powerful 125 watt output and versatile filtering the ASM 100 is the ideal universal active driver module for all subwoofer requirements.

ASM 100 Module, complete with IEC mains lead, instructions and ASM - W20 cabinet drawings. Pt. No. V7000. . . . . £185.29  
W 200 S 20cm Long Throw Drive unit for use in ASM - W20 cabinet. . . . . £38.68

### DRIVE UNITS



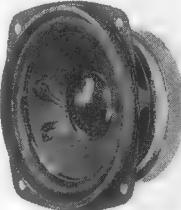
**BG30NG** 30cm. (12") Woofer. High efficiency, (95db) for sealed or vented cabinets. Peak power handling 250watts. 8 ohm. £69.61



**W200S** 20cm. (8") Woofer. Long throw unit with rubber surround and extended rear pole to give no less than 20mm cone displacement. Ideal for compact sub-woofers such as ASM-W20. 8ohm. £36.68  
NG8 Protective Metal Grille. £5.66



**W100S** 10cm (4") Low/Midrange. Coated paper cone, rubber surround, high temperature voice coil. Suitable as woofer in mini enclosures or midrange in 3-way systems. 4ohm. £11.65  
NG4 Protective Metal Grille. £2.20



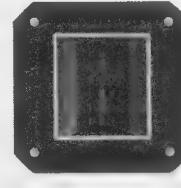
**FRS8** 8cm. (3.3") Fullrange driver. Linear frequency response between 200 and 20KHz. Large Magnet, 20mm voice coil and rubber surround. 8ohm. £8.36



**DT2.5** 10mm Polycarbonate Tweeter. High efficiency ferrofluid tweeter for use over 4,500Hz. Very good price/performance ratio. 8ohm. £8.77



**SC5** 10mm. Magnetically shielded Tweeter for use in surround sound centre speakers. 8ohm. £9.24



**RHT12S** High End Ribbon Tweeter. Superior double magnet construction gives an exceptionally low distortion and linear response from 4,000 to 30,000Hz. Cabinet cutout diameter 95mm. 8ohm. £87.77



**DHT9AW-NG** Hi-Tech, Hi-Fi, horn type tweeter. Frequency response from 3,500 to 38,000Hz and very good pulse response due to aluminium cone, Kapton voice coil and aluminium wire. Peak power handling 150W. 8ohm. £31.99

ASM100 and our 80 watt power amplifier are on demonstration at Wilmslow Audio's new premises at Broughton Astley near Leicester. Tel 01455 266603.

POSTAGE on UK orders is £2 up to £20, £4.50 over £20.

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UK

Connect the linking wires from the power supply to each of the two power amp boards. Now fit the volume control and solder the two dual-screened wires to this

case, making sure that the isolating bushes supplied fully isolate the sockets from the case and the sockets are secured tightly.

#### Wire up the speaker

### HEATSINKING

Use as much heatsinking as possible to keep the chips cool. SGS Thomson recommend 60mm of a 4.2C/W rated profile, per chip. If the amplifier is not to be driven hard, then a thick plate of aluminium (12gauge) will conduct heat away adequately. If it isn't big enough the chip will simply shut down temporarily.

Maplin stock a range of heatsinks for TO220 packages that will allow higher dissipation, like their KL-100-1, price £3.99.

and to the audio input sockets. The floating wires from the volume control connect to the amplifier boards.

Fit the speaker connectors to the rear of the

terminals with two short runs of either 49 or 72 strand speaker cable. The rib on the cable normally connects to the negative terminal, the other end of the ribbed wire going to the

power supply board earth (Fig 2). The positive lead connects to the amplifier board output pin.

Now is the time to mount each of the two amplifier boards in turn. An isolating mica washer goes between the 2050 tab and the metal of the case; it conducts heat but not electricity. Apply heat sink compound to the device and to the mica. Fit the stand-off spacer to the case and carefully mate the board to the back panel. Push an M3 screw through from the outside. Fit the screw isolating bush (used with metal screws) and lightly tighten the securing nut. Once the board is secured on the back, gently push the board onto the

stand-off. Finally, solder on all linking wires.

If you plan to use the optional heatsink, put some heat sink compound on the back and mount this to the rear of the case.

Once everything is fitted into the case, check all of the connections. Power up the unit and follow the instructions described earlier. Make final checks, connect everything up, put the 3.15A fuses into the internal fuse holders, switch on and try some music.

### PARTS LISTING

#### AMPLIFIER BOARD PARTS

Resistors	3 Band Colours	4 Band Colours	
R1 100KΩ 1/4W Metal film	Black Brown Yellow	Black Brown Orange Brown	Qty 2
R2 680Ω 1/4W Metal film	Blue Grey Brown	Blue Grey Black Black	Qty 2
R3 22KΩ 1/4W Metal film	Red Red Orange	Red Red Red Brown	Qty 2
R4 2Ω2 1/4W Metal film	Red Red Gold		Qty 2
VR1 50KΩ Stereo Log Potentiometer			Qty 1
IC1 TDA2050			Qty 2

#### CAPACITORS

C1 100μF Electrolytic 25V	marked on body of component	Qty 2	
C2 0.47μF Polyester 63V	marked on body of component	Qty 2	
C3 0.1μF Polyester 63V	marked on body of component	Qty 2	
C4 100μF Electrolytic 25V	marked on body of component	Qty 2	
C5 0.1μF Polyester 63V	marked on body of component	Qty 2	
C6 100μF Electrolytic 25V	marked on body of component	Qty 2	

#### POWER SUPPLY PARTS

Bridge Rectifier	KBP02506	marked on body of component	Qty 1
C7 4700μF	Electrolytic 50V	marked on body of component	Qty 1
C8 4700μF	Electrolytic 50V	marked on body of component	Qty 1

#### MISC. COMPONENTS

Mains Transformer	Maplins DH63T		
Case			
Mains IEC socket with internal fuse holder			
500mA 20mm Anti-surge fuse			
3.15A 20mm Anti-surge fuses			
Chassis mounted fuse holders			
DPDT Rocker mains switch			
Red 4mm Banana sockets			
Black 4mm Banana sockets			
Sleeved spade connectors			
Assorted colours of wire, including 12" of 3A mains cable			
Veroboard			
Veropins		Qty 1 pack	
Plastic stand-off spacers		Qty 2	
Assorted length M3 screws, nuts and washers			

Most of the components were sourced from Cricklewood Electronics London, with the exception of the potentiometer which is from an ALPS dealer and the transformer from Maplins.

### MEASURED PERFORMANCE

Frequency response was very wide at 5Hz-150kHz. The upper limit is arguably too high; we noticed slew rate limiting occurring. However, CD cannot deliver signals above 21kHz, so this should not be a problem in practice. There is plenty of leeway here for feedback reduction.

Power output depends upon supply volts. What you have to bear in mind is that the tiny Pentawatt package must have heat drained from it fast if it is to deliver full power without running into thermal shut down. This means mounting the 2050 tabs direct onto very thick aluminium (e.g. heat sink) or copper (acting as a heat conductor to a sink).

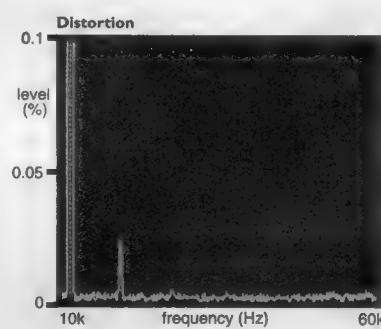
Distortion was low even at high frequencies, an impressive result. This really is a well worked out amplifier design. Distortion figures were low enough for some feedback reduction to be tolerable.

At 500mV for full output, sensitivity was high enough to suit most, if not all sources. Some budget cassette decks and tuners deliver just 300mV. Otherwise, most sources nowadays deliver 500mV-IV, CD delivering 2V of course. So this amp, as it stands, will match most sources. Sensitivity can be increased by reducing feedback.

There were no switch-on thumps and D.C. output offset measured a very low 1.7mV / 2.4mV, much like that of quality commercial amplifiers.

The TDA2050 offers a level of measured performance similar or better than everyday commercial designs. It's great for DIYers. NK

Power (8Ω)	32watts
Frequency response	5Hz-150kHz
Separation	85dB
Noise (CCIR)	-101dB
Sensitivity	500mV
dc offset	1.7 / 2.4mV
Distortion (8Ω)	
1W	full o/p
1k	0.02%
10k	0.01%





## AMICO NOTE Speaker A Winding Coaxial.

Order Code	Type/Colour Code	Construction	Price Ex. UK Val
AM-WH-550-AD	Green or red	single conductor 6AWG copper speaker wiring	0.05
AM-WH-550-AB	Black white	double strand, screened 6AWG speaker wire	12.34
AM-WH-550-AB	Black white	double strand, screened 6AWG speaker wire	25.11
AM-WH-600-AB	Black white	single core 16 SWG 90% tinned silver	168.38
AM-WH-600-AB	Black white	single core 20 SWG 90% tinned silver	362.08
AM-WH-800-AB	Black white	single core 4 Intermetallicconductor 80 strand	2,061.11
AM-WH-800-AB	Black white	20 SWG 90% tinned silver	43.98

All Audio Note speaker cables are priced per meter more

PTFE Insulated Silver Plated Copper Wire

You can also provide less expensive wires for hard wiring circuits. These PTFE insulated silver plated copper wires are 18 gauge of 15 mm wires and come in brown, black, blue, pink, red, green, orange, violet, white, and yellow. They cost £ 1.80 meter in any colour

**AMICO NOTE HIGH QUALITY STEPPED ATTENATORS & SWITCHES.**

These high quality attenuators and switches are manufactured by a friend of Mr. Kondo of ALICO NOTE, and represent the best available volume controls and switches you can get in your pre-amp. The attenuator is a 40 steps and with silver plated contacts/brushes made with an array of tantalum resistors. The switches feature silver plated contacts and self cleaning action. Used in the newly revised AMI pre-ampers, such as:

Order Code	Type	Value	Price Ex. UK Val
SWITCH-005	Blanco Potentiometer/Attenuator	1000ohm	22.79
SWITCH-005	Blanco Potentiometer/Attenuator	500ohm	22.71
SWITCH-070	Blanco Potentiometer/Attenuator	1000ohm	37.73
SWITCH-070	Blanco Potentiometer/Attenuator	500ohm	37.67
SWITCH-270	Blanco Potentiometer/Attenuator	1000ohm NEW	89.45
SWITCH-270	Blanco Potentiometer/Attenuator	500ohm NEW	87.45
SWITCH-270	2 Channel switch	8 - way	104.95
SWITCH-270	4 Channel switch	8 - way adjustable	98.75
SWITCH-270	4 Channel switch	124.75	

All of our valve based are of the highest possible quality, made from stainless and using the best metal parts from alloys which retain their spring tension around the valve pin for longer. They are recommended as upgrade to most old valve amplifiers and should be an essential part of any DIY

## SHIMON Tantalum Resistor

This is definitely the best sounding resistors available, forget the Vishay, which may be ok at high temperature transistors, but in our opinion equal to the qualities of the audio resistors. (Le directly heated triode amplifiers having feedback free in single-ended Class A). You is when you will need the tantalum resistor for the best results.

The 1/2 watt Shimon tantalum resistors are non-resonant and cost £ 2.28 each. Some values are available in 1/8 watt from Chinese at £ 4.80 each, for 10 pieces.

AMICO NOTE 2.28 1/2 watt tantalum resistors

The 2.28 1/2 watt tantalum resistors are available in 10 pieces.

AMICO NOTE 4.80 1/8 watt tantalum resistors

AMICO NOTE 10.00 1/4 watt tantalum resistors

AMICO NOTE 20.00 1/2 watt tantalum resistors

AMICO NOTE 40.00 1/4 watt tantalum resistors

AMICO NOTE 80.00 1/2 watt tantalum resistors

AMICO NOTE 160.00 1/2 watt tantalum resistors

AMICO NOTE 320.00 1/2 watt tantalum resistors

AMICO NOTE 640.00 1/2 watt tantalum resistors

AMICO NOTE 1280.00 1/2 watt tantalum resistors

AMICO NOTE 2560.00 1/2 watt tantalum resistors

AMICO NOTE 5120.00 1/2 watt tantalum resistors

AMICO NOTE 10240.00 1/2 watt tantalum resistors

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# TWEAKED! - WITH SPECIAL COMPONENTS



**Around the world, high quality electronic components for audio work are being produced by specialist manufacturers. Noel Keywood and Jon Marks review some esoteric capacitors and resistors from this field.**

**C**omponent quality is ever more widely being identified as an issue affecting sound quality. But prices remain a barrier to widespread commercial usage of the most esoteric items. But not to DIYers, who can upgrade 'at cost'.

Proper audio grade components are truly esoteric items, often with peculiar descriptions, complex performance claims and high prices. They're great for DIYers, providing an opportunity to step up in quality to a level beyond the reach of the mass audio market.

Component quality has always been an issue at Hi-Fi World. We have our own transformers and capacitors made for us and through practical experience have become well aware of the sonic signature of many components, both general purpose and audio grade. And the character of a component invariably comes

through irrespective of working conditions.

But this business is complex. Many budget components sound quite good - carbon film resistors for example. High grade components not meant specifically for audio work do not always sound better - some polypropylene capacitors for instance.

And it can be disastrous to populate an amplifier with a component having a particularly strong signature. One time, every resistor in a K5881 amplifier was misguidedly changed to metal film - it sounded awful, hard and clattery. So this is a mix 'n' match business too.

It is also a decidedly subjective business where notions of absolute correctness are hard to support. Quite often, however, there is a broad consensus, but that's very different to total agreement. A 'hard sound' can suit vinyl, but not CD.

My experience is that differences in component sound quality are easier to discern on a valve amplifier than a solid-state amplifier. This view arises from changing components in a 300B alongside our 36watt Class A design. So we used a K5881 MkII for this report, changing the components shown in the circuit diagram.

Modern plastic capacitors use a film metallised on both sides. It can be polyester, polycarbonate or polypropylene. The film is usually aluminium, its thickness determining the voltage rating. The Wondercaps tested in this report use metallised film construction.

Audio grade capacitors sometimes use a foil and film construction, which is much bulkier.

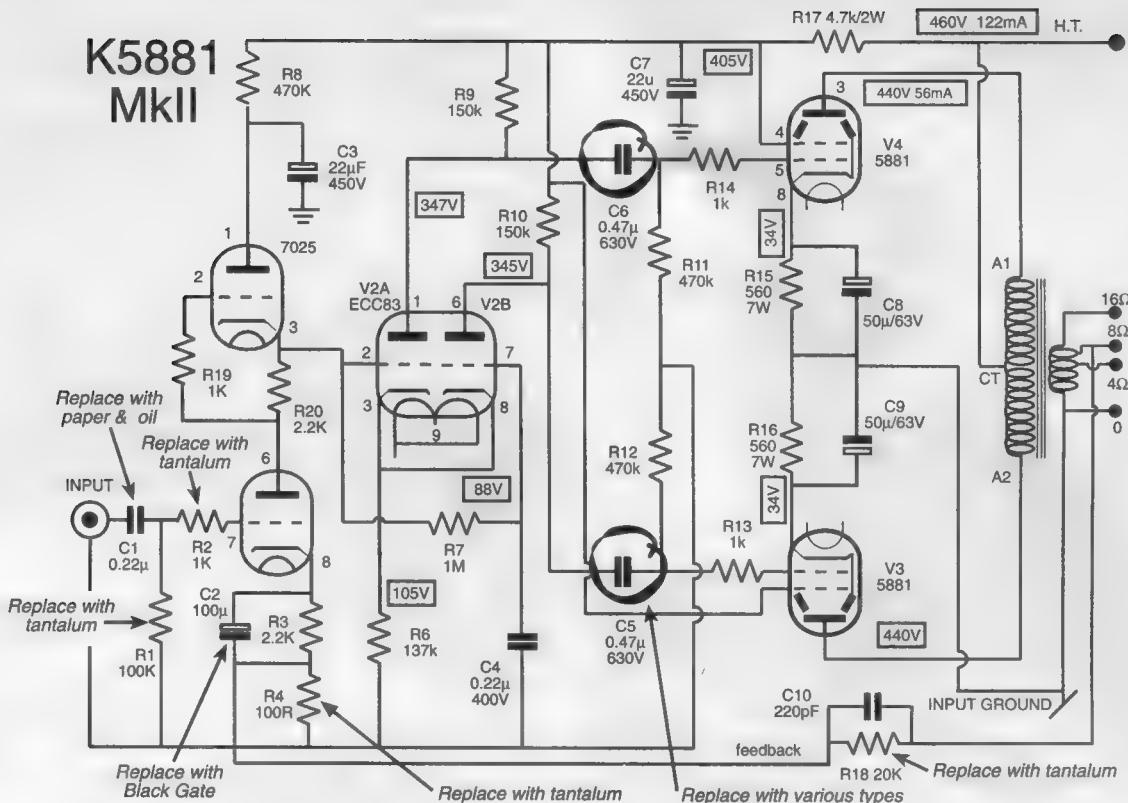
Then there's paper-in-oil. This is a rare dielectric type nowadays - we've found one manufacturer in Britain who produces it for military

purposes. These capacitors are made by forcing oil into paper under pressure and heating in a sealed tank. It's an old-fashioned method that yields variable results. Paper-in-oils can leak (electricity - not oil!) but they have a good reputation for sound quality.

Electrolytics provide very high capacitance from small size, but have mediocre performance in most other areas. There are legions of special types as a result. Rubycon make various audio grade specials, like the famous Black Gate. This reputedly uses an electrolyte with a graphite additive, developed by Japanese manufacturer Jelmax.

Carbon film resistors are most common and usually sound pretty good. Metal film types such as Holcos are considered a step up, but for this report we tested tantalum film resistors, manufactured in Japan and imported into Britain by AudioNote.

# K5881 MkII



## THE COMPONENTS WE TWEAKED

**COUPLING CAPACITORS C5 & C6** - In this position the K5881 kit's standard capacitor is a  $0.47\mu\text{F}$  metallised film polyester capacitor with 400V across it. In its place we soldered in: HOVLAND MUSICAP  $0.47\mu\text{F}$  600V film and polypropylene foil capacitors; TRT WONDERCAP  $1\mu\text{F}$  425V metallised polypropylene film capacitors; AUDIO NOTE paper-in-oil  $0.39\mu\text{F}$  600V capacitors.

**INPUT CAPACITOR C1** - This was replaced with an AudioNote  $0.22\mu\text{F}$  400V paper-in-oil.

**FEEDBACK BYPASS CAPACITOR C2** - This was replaced with a  $100\mu\text{F}$  6.3V Rubycon Black Gate electrolytic.

**INPUT AND FEEDBACK RESISTORS** - These were replaced with tantalum resistors.

## STANDARD POLYESTER CAPACITORS (56p each)

JM - Tori Amos' vocals and harpsichord were both powerful and smooth, integrated within an acoustic whose size was clearly audible through the Sextet IIs. The grungey electric guitars which join the song in its second half had an attractive 60-a-day roughness to them, which is just as it should be. Individual images hung together in a cohesive sound stage, good tonal balance leading to an even-handed presentation.

The ebb and flow of piano and strings showed that dynamic contrasts posed these caps no problems, with further proof in the weight of the piano's bottom end and the expressiveness of vocals. Extra bass brownie points were garnered for the focus and impact of the conga on 'Talula' and the drum



machine on 'Professional Widow'.

The acoustic was once again well fleshed out on Vivaldi's Four Seasons, where imaging was stable, separation good and detail fine. Rhythm and timing were also present and correct, as I found out with the 'Danza Pastorale', its violins tripping along, joined by the drive of the well defined cellos.

NK - Very clear and precise. Typical film capacitor glassiness, close to audio grades but a little less insight, fine detail and smoothness.

confessed bass-head, the AudioNotes produced the kind of taut, tuneful bass that put a grin straight on my face - the groove factor in the music had just risen a couple of notches on the shake-your-booty meter.

The sound as a whole opened out, different layers within the sound stage becoming more obvious - individual images were now easier to make out within the larger acoustic these capacitors developed. They also showed an overall control and grip which never quashed the vitality of the music, instead enhancing it by making the music easier to listen to.

There was greater detailing to images as well, giving them a fuller, more three-dimensional feel and knitting them more convincingly into the sound stage. This detailing extended to the treble, with cymbals and strings benefiting from

## AUDIONOTE PAPER-IN-OIL CAPS (£12.75 each)

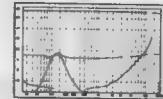


Bass immediately stood out for its extra detail, speed, impact, extension and focus. It was as if someone had hit the loudness switch, but instead of fat, bloated lower registers, there was suddenly another octave of hard-hitting bass on tap. As a self-

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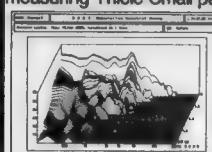
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impressive tonal subtlety and insight.

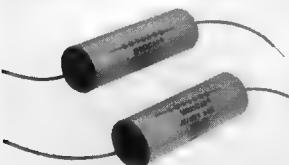
One major difference between the AudioNotes and the standard capacitors was a softer midrange that was less forward and incisive, giving Rock a mellow character. NK - Always different from synthetic film capacitors, these paper-in-oils soften out the mid-band a little but give enormous amounts of clean high frequency detail. Most surprising was their significant extra bass extension, with improved impact and raised level.

#### HOVLAND MUSICAPS (£12.86 each)

The Hovlands' midrange is similar in presentation to the 'standards' in its forwardness, but has a delicacy of detail closer to the paper-in-oil capacitors. Tonally, the Musicaps had a wider palette to paint from as well, with violins and cymbals in particular coming across more realistically.

While the Hovlands' bass was tight, detailed and fast, it lacked the sheer weight and impact that the AudioNotes possessed. This meant that acoustics were rendered on a smaller scale, the sound stage missing out on some of the width and depth that had been discernible with the paper-in-oils.

The overall balance of the music tipped away from the visceral of the AudioNotes towards the analytical, becoming a little less engaging in the process. Rock fans



might well go for this approach with its crisp, precise speed though. And the way images stood out cleanly in the acoustic means that these caps will never sound confused, even on the heaviest of mixes.

NK - Similar in basic

presentation to the standard polyesters, but with stronger outlining, more detail and more upper midband projection.

#### TRT WONDERCAPS (£5.50 each)

These capacitors continued the plastic family tradition of forward and incisive midrange, as the likes of Grace Jones, the Chemical Brothers and Vivaldi proved. With the latter there was a broader sound stage and deeper bass than had been the case with the Musicaps. The music flowed along rhythmically, these caps showing off their prowess in the timing area with an impressively foot-tapping rendition of 'Setting Sun'. Detail was abundant - I had no problem homing in on the individual samples plastered all over this song. While the TRTs' bass plumbed greater depths than the Hovlands, it didn't go as low as the AudioNotes.

Vocals proved the



smoothness and power of these caps, with the expression in Tori Amos' singing particularly impressive. Backing violins and harpsichord were less glassy due to a broad tonal range that fell halfway between the paper-in-oils and the Musicaps. Images were properly detailed and proportioned and sat within an attractively transparent sound stage. The TRTs seemed to combine the incisive, forward midrange characteristic of the plastic caps in this test with some of the broad tonal range and low-level detail retrieval of the paper-in-oils.

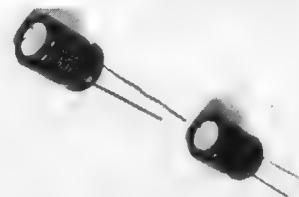
NK - A little less extreme in upper mid-band glassiness and projection than the

Hovlands, a little better in overall balance due to stronger bass too, although not a match for the paper-in-oils. Very good.

#### JELMAX BLACK GATES (£1.83 each)

The effect these tiny electrolytic capacitors had on the sound quality was far from small. From the first moment that music started coming through the Sextet II's, it was obvious the Black Gates had cleaned up the overall sound, removing a layer of grunge from the amplifier's presentation.

Tori Amos' piano and vocals were now firmer as well as more dynamic and realistic, their images packed full of a subtle detailing that never became overwhelming.



The band members were solidly positioned in an acoustic made recognisable thanks to the transparency the Black Gates brought to the proceedings. With the extra breadth and width the sound stage now possessed, music took on life-like proportions and was much more involving.

The Black Gates seemed to have a similar affect to the paper-in-oils where bass was concerned. They removed the mush that normally obscures the cues in the lower octaves that build up an acoustic and add space to the sound stage. But they also tidied up the performance of midrange and treble, with greater insight and detail, especially obvious on strings, lending Vivaldi's Four Seasons a realism that made listening addictive.

NK - Phew! The Black Gate lived up to its reputation, one little capacitor immediately improving image body and solidity right across the audio band. This component change

was the best we made in my view.

#### AUDIONOTE TANTALUM RESISTORS (£1.99 each)

NK - These were added into the circuit in the positions shown in the circuit diagram. Their effect was quite obvious, being not too dissimilar to that of metal film resistors. They brightened and hardened up the sound, adding some high frequency



'hiss' to cymbals that warned there was now a little too much emphasis on high frequency retrieval. Our overall view here was that these resistors need to be used with care and according to conditions. The Tonigen ribbon tweeter of the Heybrook Sextets is one of the most revealing going; others may make more or less of the effect. Also, what comes over as extreme glassiness and hardness with CD sounds far more acceptable with LP, posing the question: are these components simply revealing more of CD's problems?

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# ACOUSTICS and PSYCHOACOUSTICS

by David Howard and James Angus.

Reviewed by Noel Keywood.

Books on acoustics are becoming more common, but each has its own particular approach to the subject. Traditionally, the area has been split between two camps: musicians and architects. Seashore's *Psychology of Music* (McGraw Hill) is an early example of the first and Beranek's *Acoustics*, available from our World Library (p58), an example of the second.

Both are what I would loosely term 'mechanistic'. There is another emergent camp that approaches the subject from the other direction, looking at audible perceptive strategies from the biological viewpoint. It seeks to understand our hearing function in evolutionary (Webster, Popper and Fay) and psychological developmental terms. This approach concentrates on our interpretations of what we hear, is a branch of medical science and is producing, in parallel to the mechanists, a large body of fascinating information. As Yost says, "in the past a distinction has been made between sensation and perception", perception being treated in vague terms.

The traditional mechanistic approach to psychoacoustics is under fire from others in the field, who feel its explanations either don't go far enough or are just plain useless. "A number of investigators have argued that audiogram thresholds and other psychoacoustic measures correlate poorly or not at all with those measures attempting to tap a listener's ability to function acoustically in daily life".

I mention all this to get Acoustics and Psychoacoustics into perspective. It comes firmly from the mechanist camp. And it does a good job. But when I see the word "psychoacoustics" I do rather wonder whether I've got to plough through dense paragraphs and complex diagrams of hairy cochleas, of more use to a surgeon than someone, like myself or a potential purchaser of this book, who needs to make sense of our senses.

In this case, the cochleas have it, together with the conchas, incus and all manner of auditory bits and pieces, from

page 66 onward. However, that is not to deny that the book covers valuable ground. It is written by and aimed at those interested in music recording and performance.

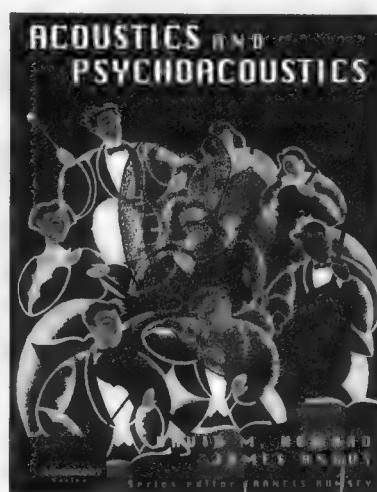
Early chapters cover the usual ground, considering air speed, wave compression, reflection, refraction, resonance and various other physical phenomena. There is a useful number of equations, but the authors have tried to make the book easy to comprehend. The explanations are nonetheless comprehensive and detailed.

After talking about the physics of sound and the biology of the human auditory system, the book moves in apparently logical progression to Notes and Harmony. Here we are getting firmly into music theory and some of it I found fascinating. I had always thought that the good Dr Ohm was an expert on

Masking follow, with the inevitable reference to 'deception' that engineers make when discussing masking effects. I'm sure Yost would see 'deception' more as a sophisticated biological form of 'optimisation'.

The penultimate chapter considers rooms, studios and acoustics. It covers basic theory more than practical acoustics solutions, although I was amused to see the use of side wall absorbers to produce a reflection-free listening zone in a room, since we regularly recommend this. However, the influence of the rear wall, and of diffraction as an alternative to adsorption, are not discussed. The book quite often resorts to theoretical generalising where, I suspect, the authors have little practical knowledge. And finally, in the last chapter, electronic sound processing, including equalisation, phasing, reverberation, compression and other studio effects are covered very quickly.

Leaving me to categorise this book as a good choice for music students - and ear surgeons. Its approach is more theoretical than practical, but for anyone studying acoustics for the first time the explanations are about as easy as they come and the coverage wide too. But everyone in audio ought to be aware that human auditory perceptive strategies are not as simple and mechanistic as traditionally presented in books like this. Making the scope of the 'psychoacoustic' contribution a bit limited and limiting. I would like to have seen a bit more breadth of discussion in this important and profound area. ●



current through resistors, but it seems he also developed an acoustical law. Coverage of psychoacoustics from this point of view, namely how we perceive groups of tones and such like, is thorough and well supported with references, both within the chapter and at its end.

The arrival of Chapter 4 clearly signals which way this book is heading. Entitled *Acoustic Model for Musical Instruments* it explains how musical instruments work, including human vocalists. The subjects of Timbre and

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# AUDIO POWER AMPLIFIER DESIGN HANDBOOK

by Douglas Self.

Reviewed by Andy Grove.

The Audio Power Amplifier Handbook follows from a series of articles by Douglas Self published in Electronics and Wireless World, but of course the book allows the author to cover the subjects in greater depth. Mr Self is a respected audio engineer and currently designs professional equipment such as consoles for the Soundcraft Electronics company.

Douglas has analysed the distortion mechanisms of the various stages of the amplifier and presents methods for their reduction or elimination. In the opening chapter Doug attacks the subjectivist movement with a vengeance. It's all done very logically and the arguments presented seem valid. Here also the general requirements of power amp performance are laid out, with safety and reliability first and foremost, progressing through well known lab test parameters such as damping factor and distortion.

The second chapter gives the reader a quick overview of two possible amplifier topologies. The different classes of operation such as A, B, and H are described quite briefly, but the book really concentrates on Class B output stages. A 'for' and 'against' list of features for AC and DC coupled amplifiers is also presented. From there Self goes on to justify the use of negative feedback, his argument mainly hinging on how it reduces distortion. But he also points out that the distortions produced at each stage can be minimised before feedback is applied, maximising its effect.

In Chapter 3, Self's eight distortion mechanisms are introduced. These are distortions which he seeks to reduce to make an amplifier more linear, before feedback is applied. Here also the 'generic amplifier' is introduced. This is the almost universally used three-stage circuit with input differential pair, voltage amplifier and output buffers.

The next three chapters offer a step-by-step analysis of the generic circuit, starting at the input differential pair and proceeding through the voltage amplifier to the output stage. The analyses are in depth and Spice models are used to predict behaviour, together with some

real-world prototype circuit tests. All kinds of goodies are described, such as current mirror loading of the input pair, constant current sourced VAS stages and the innumerable different output stage types from the simple emitter follower to complex triplets.

Chapter 7 covers the issues of

## Audio Power Amplifier Design Handbook

DOUGLAS SELF



stability, compensation and slew rate in great detail and Self illustrates the various effects of the amp's set-up, such as input stage operating current on its high frequency and slewing performance.

The following chapter investigates the power supply and its effect on performance. Even the wiring and earthing of the circuit is taken into account. This is valuable for less experienced engineers. Self concludes that the best approach is to maximise the amp's power supply rejection ratio rather than making the supply super stiff and quiet.

Chapter 9 is all about Class A amplifiers. They are introduced as a way to decrease distortion from the output and driver/voltage amplifier stages. In this chapter there is a very novel output stage quiescent current monitor and controller and the 'Trimodal' amplifier which can be a Class A, B or AB.

In Chapter 10 the FET output stage is explored, but Douglas is not a fan of the

FET, mainly due to its lower transconductance manifesting as higher distortion when used as a follower, so this chapter is quite brief.

Chapter 11, entitled 'Thermal Dynamics of Class B Output Stages' addresses just that, and Self uses Spice modelling techniques to predict thermal performance by converting various thermal elements to electrical ones. The thermal issue is a very important one, not only for the purpose of reducing distortion but for the practical reason of avoiding thermal runaway and output stage self-destruction if you get it wrong!

The final three chapters are practical and down to earth. Covering protection circuitry, mechanical design including PCB layout and final testing.

For those who want to build a reference quality solid-state amplifier this original book is essential. But it should form part of a library and not be taken as the bible of power amps because it is very specific in its coverage. There are numerous other topologies, apart from the 'generic amplifier' topology, which may or may not offer advantages.

Douglas Self has made it a personal quest to perfect this particular amp topology, something I thought Hitachi did back in the Seventies with their super high feedback MOSFET amps. Self's criterion of amp goodness is to have the maximum amount of zeroes before the one in the distortion figures. It's like trying to characterise a car from the engine's power output or wheel diameter; it's all just specs in the end.

This is an original and informative book written in a very easy to understand style, which indicates that the author knows what he is talking about. But I wish Douglas would discard his Paisley shirt and psychedelic kipper tie, put a little more faith in his senses, and a little less in his test gear.

### Audio Power Amplifier Design Handbook

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# D.I.Y. Letters

## POWERING UP

I am looking to squeeze a bit more performance out of your phono head amp, and am considering building a beefier power supply. My inspiration is the Michell ISO, which sounds much better with its Hera power supply.

Would this be a worthwhile proposition? If so, how far should I go? If I follow the Russ Andrews school I would end up with a 200VA or so transformer and 20,000 $\mu$ F reservoir caps on each rail. While I would be prepared to build something along these lines, I assume that something smaller would fit the bill. Can you suggest something?

Also, if I do uprate the power supply should I also replace the voltage regulators with something rated a bit higher, say 1 amp or so?

Steve Hall  
East Carleton,  
Norfolk.

**Andy Grove (ex-Hi-Fi World, now Audio Note) says -**

You could do quite a lot to increase the sonic performance of your head amp. You could upgrade the electrolytic capacitor to Black Gate types and possibly fit tantalum film resistors, but you seem to be concentrating on the power supply and it's quite often a good place to start.

Ideally you would use a choke input filter and low noise shunt regulator. We've got some high current chokes for filament supplies at Audio Note. Using a large capacity mains transformer and reservoir caps could work quite well. Linear Technology make high performance regulator ICs. Check the audio parts guys' catalogues.

One tip is not to put a super large capacitor on the output of the regulator chip; the data sheet will advise. Also, it may be worthwhile putting a small resistor

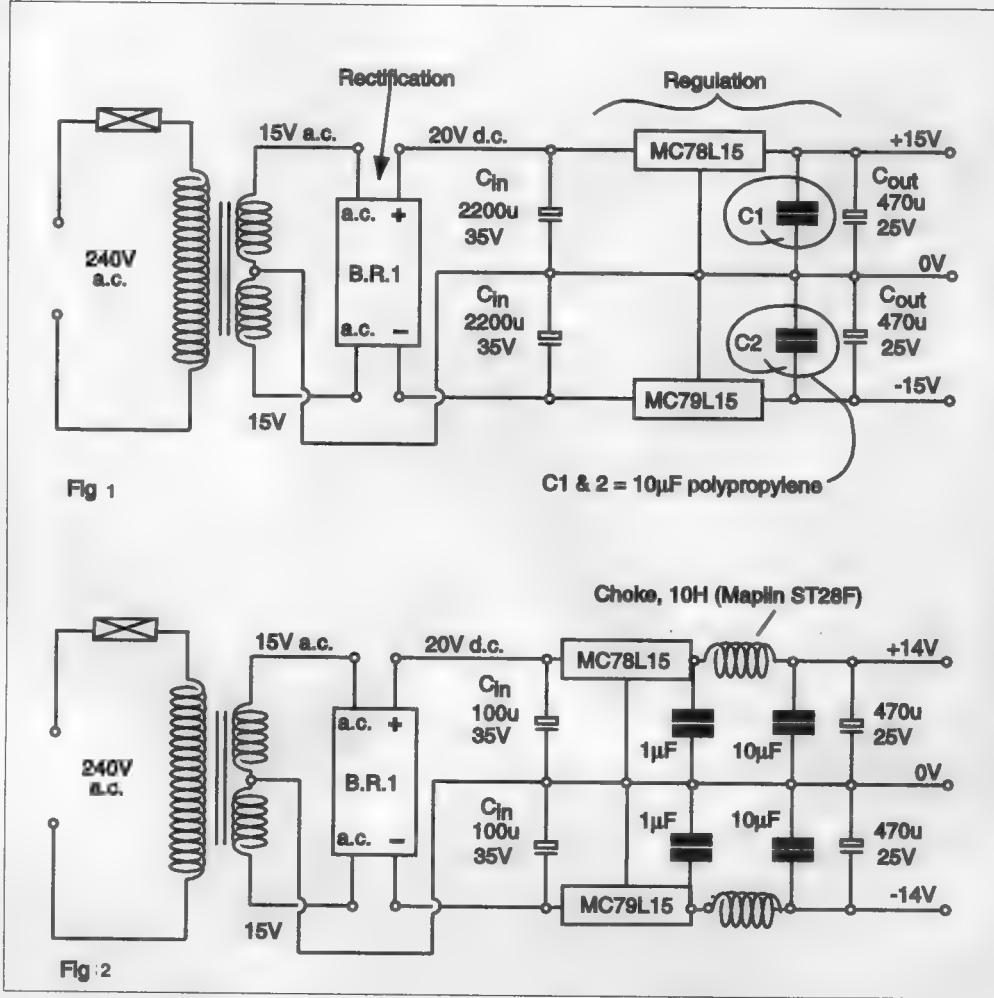
between the output of the chip and the cap, 10 ohms say.

Another way of making a super cool regulator might be to use a high performance power op-amp IC and a voltage reference IC for each rail. Make sure the power op-amp has a good frequency response, and again be wary of using large capacitors on the reg's output.

A word of warning, shorting the regulators output may result in instantaneous destruction of the op-amp unless it is internally protected. Of course this is only likely to happen if you are careless with the meter probes. There are various circuits around in the reference books from Maplin and so on, for discrete and IC regulator circuits, check them out. AG

## Noel says

There are many forms of power supply, each with its own strengths and weaknesses, as well as



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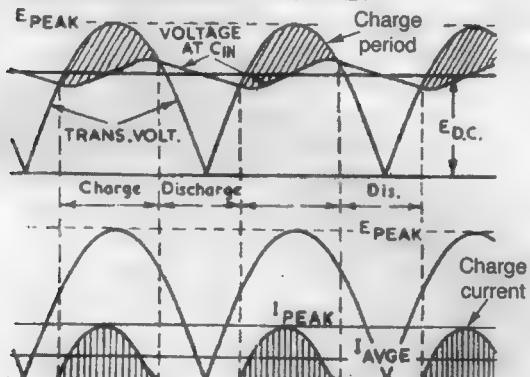
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adherents of course. Here are some options, that relate to power supplies in general, you might like to consider.

### CAPACITOR INPUT SUPPLY



### CHOKE INPUT SUPPLY

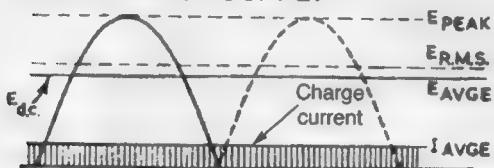


FIG 3

Our phono stage power supply uses a normal capacitor input topology where rectifier B1 charges 2200 $\mu$ F 'input' capacitors. This provides a fairly hum free 20V that feeds the MC78L15 (+ rail) and MC79L15 (- rail) voltage regulators. These hold the output voltage steady irrespective of input voltage (i.e. mains) fluctuations or output current variations. It's simple and it guarantees DIYers a 15V line free of hum, since both the capacitors and the voltage regulator act to smooth the supply. The AD797 supply voltage is rated at 15V maximum and running the chip at full line volts gives maximum signal output swing of around 10V rms.

This is a safe, cheap and reliable supply, of a sort much used generally. However, chip voltage regulators have a very low output impedance that defies the efforts of output capacitors to swamp their influence. I've experimented with many such regulators and find they are noisy, about which little can be done.

Note what Andy says here. Furthermore, looking backward from amplifier into power supply, the amplifier

determined by its dynamic behaviour, noise etc will influence the load. So, in effect, you end up listening, in part, to the voltage regulator. That is why Andy recommends using a high performance audio power amp as a regulator; it is also why valve regulators are best.

Generally speaking, solid-state voltage regulators work best at low frequencies and invariably give tight sounding bass, but they are less pleasant across midband and treble. If you increase input capacitor  $C_{in}$  you pulse the transformer and mains supply more heavily, as transformer volts rise above  $E_{dc}$  to  $E_{peak}$  (top trace in Fig 3) which is not a good idea in principle, although in this case little current is being drawn, unlike a power amplifier.

Increasing the output capacitor,  $C_{out}$ , will have little effect, because of the voltage regulator's low output impedance. All the same, you will find a large value polypropylene across the output 470 $\mu$ F electrolytic,

as shown in Fig 1, cleans the treble.

The best way to decouple the power supply from the amplifier, and to draw current more smoothly from the transformer, is to use a choke. It might seem daft to put a choke after a voltage regulator, since the DC resistance (150 $\Omega$  in the Maplin choke) destroys the regulation, but in this case the regulators are there only to guarantee the lines can't rise above 15V. A large value choke (3-10H) decouples the amplifier stage from the supply effectively and makes the output capacitor more influential. Use a 470 $\mu$ F/25V Cerafine or Black Gate as an output capacitor, optionally bypassed by an audio grade polypropylene - experiment to see what you prefer.

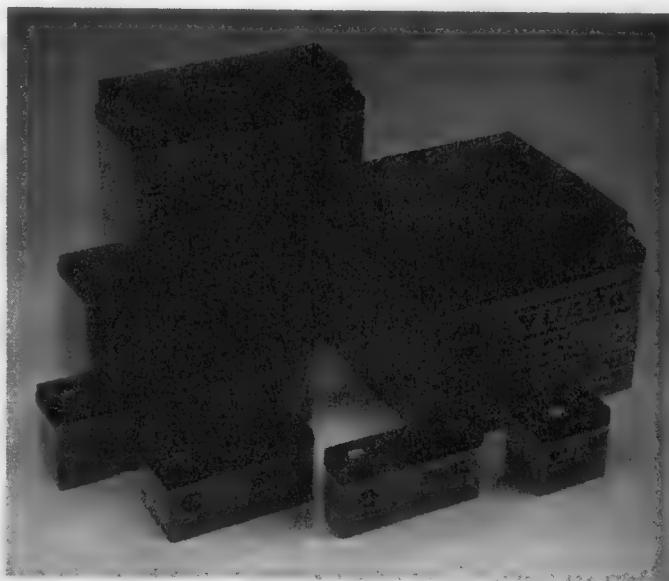
Providing the input capacitor is kept low, around 100 $\mu$ F or lower if hum is not a problem, then current draw from the transformer is smooth over the whole of a voltage cycle, as shown by large in the bottom diagram.

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A range of maintenance free, sealed construction lead-acid batteries combining small size with high output and long life, in 6V and 12V versions from 1Ah to 38Ah. The batteries are classified as 'non-spillable', having unique sealing techniques to guarantee that no electrolyte leakage can occur. The batteries are provided with a means of recombining gas internally during normal usage, and in the event that a build-up of gas at excessive pressure should occur, a low pressure venting system, operating at 7 to 10 psi, will dispel the excess and reseal itself. The 'non-spillable' feature of these batteries means that they can be operated in any position, unlike the usual form of vented lead-acid battery which is strictly 'one-way-up'. A service life of 5 years should be expected if the batteries are used most often in the 'floating' or 'standby' modes of operation, where top-up trickle charging is regular and discharge is infrequent. The batteries also feature a low 'self discharge' rate of only 3% of rated capacity per month, allowing the battery to be left unused for some time without loss of efficiency or any appreciable deterioration of

MAPLIN catalogue, tel: 01702 554161



#### Charging

Because these lead-acid batteries are sealed, some care has to be exercised whilst charging, and it is recommended that a stabilised, constant voltage source should be used, with current limiting proportional to the battery's Ah rating.

Car battery type chargers must never be used. Battery performance and service life will be directly affected by the choice and efficiency of the charging circuit used. Constant voltage charging is the most suitable method, and the output must be within 2.25 to 2.30 volts per cell for trickle charging, or in the case of 'cyclic' use 2.40 to 2.50 volts per cell.

In effect, the choke, being a reactance, stores energy, releasing it into  $C_{out}$  and the load, during the discharge period. This will improve sound quality. You might be interested to note that  $C_{in}$  should be made as small as possible in this arrangement, and  $C_{out}$  made large. This arrangement approximates to a choke input power supply, considered something ideal, although a pig to implement I have found.

Another option seriously worth considering with a high gain, sensitive preamp in particular, is to go battery. Use two 12V sealed lead acid types, which have a very low output impedance, one for each rail. Recharge them over night. The Yuasa XG74R from Maplin at £18 apiece will suit. **NK**

## QUICKSILVER MESSENGER

In Australia I have just obtained a copy of your October '95 issue and I think I can help Andrew Footman from Wolverhampton, who asks for information on the Quicksilver amplifiers, in particular the 8417 valves.

Note that the ratings for the KT88s are for genuine GEC M.O. Valve Co. By all accounts, the Chinese derived KT88s (currently available through PM Components, Golden

Dragon, Billington Gold et al.) are better run at considerably lower plate voltage to avoid flash-over problems.

Typical operation points for all the valve types listed at a B+ of 450V are almost identical - around 50mA standing current per tube, with a grid I bias of -15V to -20V. In fact, the 8417 needs a slightly lower bias voltage, which means it is very easy to drive.

Based on these ratings, Andrew could directly (well, almost directly - see

RATINGS	8417	6550	KT88	EL34
Anode volts	500V	660V	800V	800V
Screen volts	500V	500V	600V	425V
Anode power	35W	42W	42W	26W
Screen power	5W	6W	6W	8W

info on pins below) substitute a KT88 or 6550 and be well within the design centres for any 8417 circuit.

The KT88 and 6550 can be directly substituted for the 8417, with one ESSENTIAL check needed. I have a base diagram for the 8417, which shows their plate internally linked to both pins 3 and 1. Andrew would need to check that the Quicksilver plate leads go only to pin 3. If so, the following pins apply for the three types:

- Pin 1. no connection
- Pin 2. heater
- Pin 3. plate

Pin 4. screen  
Pin 5. grid  
Pin 6. no connection  
Pin 7. heater  
Pin 8. cathode

My info. on the monoblock Quicksilver is that they are 100W ultralinear amplifiers. I don't have any info. on their HT, but I suspect it would be about 450V, with a standing current of about 55mA per valve. See sketch of circuit.

If the B+ measures less than 430V, the EL34 could be substituted, provided that pins 1 and 8 are linked. The other pins are identical. My recommendation would be to find a decent set of

KT88s, join pins 3 and 4 together with a 100 ohm resistor, and run them as triodes (disconnect the screen taps on the output transformers). Andrew would then have 50 watts of class ABI triode power - a real challenge to the Audio



Research Classic 60s. If the EL34s were strapped as triodes, he would get about 35W.

I hope this is useful information for Andrew, if he hasn't already had help from elsewhere.

**Andrew Neale**  
Modbury Heights,  
South Australia.

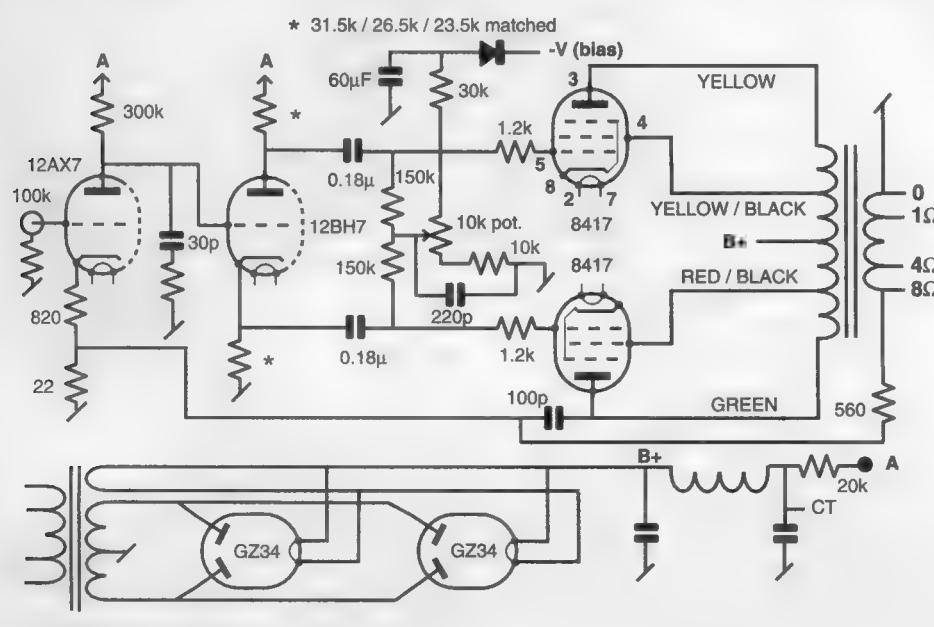
Thanks. We have reproduced your circuit from fax and hope it is correct, since some values were not clear and B+ is commonly on the output side of the choke. Our base diagram for the little mentioned 8417 comes from the Tube Substitution Handbook. Here, the plate (anode) goes to 3 alone and 1 is either an optional Screen (not an electrode) or No Connection, according to the manufacturer. **NK**

## ULTRA-LINEAR

I was most interested to discover your magazine last year as one which treats valves and vinyl seriously and I found your comments on valve amplifier design in the November supplement most interesting particularly your rejection of ultra-linear operation for your K6L6 and K5881. Following the Mullard and GEC treatises I had been brought up to think of this as the 'be all and end all' of amplifier design.

I do however have a couple of queries. Firstly much has been written on the superiority of triodes over pentodes as output devices but I have never seen any comments on their pros and cons in earlier stages of power amps or as preamps: do similar comments apply? The Mullard power amps all use pentode inputs whilst GEC go for triodes and Quad seem to have taken the GEC design and replaced two triodes with a pentode. For preamps all three use a mixture of triodes and pentodes.

In my own aged equipment all except outputs are triodes. Rogers for example in my Cadet 3 drives the output pentodes from a



QUICKSILVER AMPLIFIER (one channel)

single triode anode/cathode phase splitter with gain provided by a preceding triode voltage amplifier. In the preamp section he uses a further 3 triodes to get from the MM phono input giving 5 triodes in all per channel the first 3 being the now rare ECC807, designed specifically for this application as a superior low noise ECC83. Going further back to my state of the art domestic audio of 1950 (a KB radiogram) the output tetrodes are driven by an amplifying phase splitter using two triodes (GEC's 'floating paraphase phase inverter') preceded by a voltage amplifying triode for the detected radio signal. A fourth triode is brought into use for phono for the weaker signal from the Decca XMS variable reluctance pickups.

Neither piece of equipment uses UL output and seems to manage well enough without: QED I suppose. Indeed I imagine I would have to expend a fair amount of cash to better the musical quality of the Rogers on my preferred (classical) listening. How would your K5881 or K6L6 compare I wonder?

Secondly, I find that in general I get a more immediate, lively and atmospheric sound from LP than CD making music more involving with the former. With the Rogers I use a Goldring-Lenco GL75/Shure M75ED T2 combination and a Technics SL PG 460A CD player. Speakers are Wharfedale Lintons I 're-engined' a year or two back with Audax 1" soft dome and 8" paper cone/foam surround units and 4 new element crossovers. I thought I perhaps had a bright cartridge and dull CD player but the Technics got excellent reviews and when I bought it I also auditioned the much lauded Marantz CD63 but thought that sounded rather dull and didn't like it.

Would upgrading to a

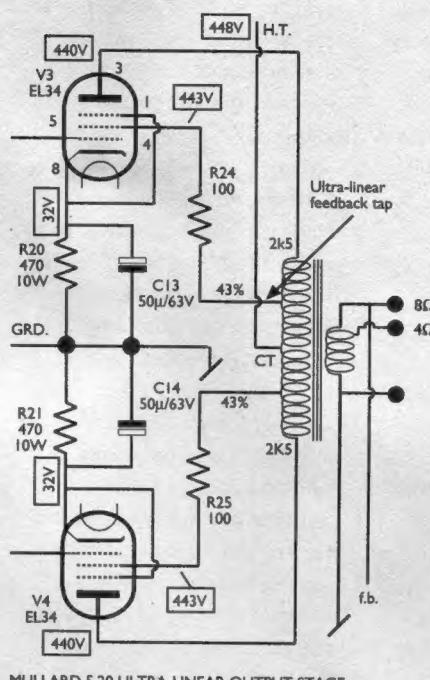
better CD player give me a more LP like sound? I suspect not and that the problem lies in the nature of the medium itself. When I have heard new DDD CDs which I also posses on the radio they have the same rather anodyne sound and yet with the odd disc the Technics shows it can provide a lively sound. Mercury 'Living Presence' CDs seem sharpest (perhaps due to their careful remastering, playing the mastertapes on the original valve recorders on which they were made). In one case where I have the same item on Mercury LP and CD the sound is virtually indistinguishable; in other cases where I have the same recording in both formats LP is always more immediate.

Finally I note that the distinguished audio panel in the magazine 'International Classical Record Collector' in their comparisons of a CD with various different LP cuts from the same master have so far always placed the CD last for audio quality. Enough said!

I would be interested in any comments you may have.

**Nicholas Coleman  
Newton-le-Willows,  
Merseyside.**

The output transformers of our K5881 amplifier have a high primary impedance, which helps keep the output stage intrinsically linear. It offers better measured performance, I found, when using the linear 6L6 valve (in rugged 5881 form) than an EL34 working in ultra-linear mode. Feedback skews an amplifier's transfer characteristic and did so when applied from a transformer with ultra-linear taps. Distortion changed in its harmonic structure as level rose. What this means is that



MULLARD 5.20 ULTRA-LINEAR OUTPUT STAGE

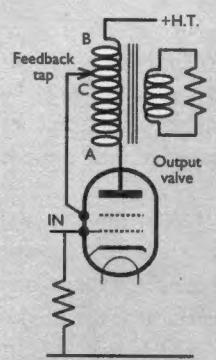
are problems with ultra-linear in that unless the output transformer is very special the screen tap will not be coupled to the anode at high frequencies and instability results. This made the old designers put caps and resistors all round the transformer to stop oscillation. Also, the commonly used 43% is not correct for every operating condition or valve. The tapping point has to be designed in."

Running the K5881 output stage 'straight', with the 5881 screens just a few volts below the anode produces just a small amount of second harmonic distortion, an innocuous characteristic. However, this is specific to the 5881 valve, which draws little grid current due to the electrode alignments. Generally, the advice is to run the anode of a tetrode at as high a voltage as possible and the screen at half anode volts, from a 'stiff' supply (i.e. one that is regulated). The ideal is postulated as a 50% tap on

#### ULTRA-LINEAR OPERATION from AMPLIFIERS AND SUPERLATIVES by D.T.N. Williamson and P.J. Walker.

If the tap is affixed to point A, giving a coupling factor of unity, the stage behaves as a triode, if at B as a simple tetrode. If now the screen is tapped at intervals between point B and point A there will be a progressive inclusion of the load impedance in the screen circuit and a progressive change from tetrode characteristics at B to triode characteristics at A.

In the case of the single valve there would appear to be little gained from this circuitry. With push-pull the reduction in distortion is greater than the reduction in gain, because of the cancellation of second harmonics. This "something for nothing" is small, however, and can be lost or even reversed if there are any appreciable departures from precise balance at any frequency.



BASIC ULTRA-LINEAR CIRCUIT

the mains transformer secondary, regulated to keep within the screen voltage rating - often 300V or so. A common approach is to use a potential divider to establish this voltage. Such an approach maximises power output and keeps screen current down.

However, I have to say that with K5881 this approach was tried and did not work, reducing power and increasing distortion, showing that much depends upon individual circumstances and components.

Recently, I reduced feedback in K5881 as far as possible (to 18dB) consistent with an upper bandwidth limit (-1dB) of 20kHz. This has helped open up the sound, improving depth perspectives in particular.

It's probably best to say that CD and LP are just 'different'. By and large, cheap CD players do a better job than cheap record decks, as well as being more convenient of course. The situation changes as price goes up, because CD is performance limited by its old 1970s digital coding system, whilst LP, being analogue, is not. So the more money you throw at it, the better it gets. **NK**

#### Andy Groves says -

There are four fundamental differences between triodes and pentodes;

1. For a given transconductance a pentode will generally give higher gain than a triode due to its much greater internal impedance.

2. The positive potential on the screen grid allows a pentode to sink more current at low voltages than a similar triode, this equates to higher efficiency in output stages.

3. For a given transconductance a pentode

will create more noise than a triode due to the random distribution of currents between the anode and grid screen.

4. Pentodes are easier to drive at high frequencies, in a triode the Miller Effect loads the input capacitively at HF, but the screen grid in the pentode prevents this.

There is possibly a fifth and that is that pentodes tend to produce a more complex harmonic distortion pattern than triodes, but it does depend on how the pentode is being used. In output stages pentodes do usually produce higher order harmonics than triodes. So the pentode is more efficient power wise, has higher gain and is easier to drive at high frequencies thereby making wide bandwidth more easily achievable. The triode however is quieter and generates simple low order harmonic distortion and its low impedance helps with speaker damping. These criteria are important for audio quality amplifiers and for the best amps triodes are usually chosen throughout.

In output stages one would ideally want the high efficiency of the pentode and the low distortion of the triode. There have been several attempts at achieving this performance and Ultra-Linear was one of them. To make a pentode operate as a pure pentode the screen grid is held at a rigidly fixed voltage. If however the screen grid is connected to the anode, the pentode starts to operate like a triode. Engineers thought that if they could connect the screen to a voltage which was somewhere in between they might get some of the advantages of both the triode and pentode. They connected the screen grid to a tap on the output transformer so that a percentage of the anode swing was fed into the screen

grid. A 43% tap (a commonly used value) feeds 43% of the anode voltage swing into the screen grid. They found that it was possible to make a mutant hybrid of pentode and triode which gave good efficiency like the pentode but which also gave more even-order distortions which would hopefully be cancelled by the push-pull operation.

Unfortunately, they soon discovered that just bringing out an extra wire part along the main primary winding caused stability problems and so resorted to adding extra components around the output transformer or making very complex windings. It seems that Ultra-Linear fell from grace due to it being a bit of a pain in the butt. **AG**

#### DIPOLE DYNAMICS

Your article on the equalised dipole subwoofer was extremely interesting, since I have been working on this very topic for almost two years now.

I substituted your equalisation circuit for my own, which incidentally had the same equalisation minus the 140Hz peak. The benefits were immediately noticeable - much improved transients and a feeling of increased speed at low frequencies.

Increasing the peak slightly to 3dB improved things even further, although there was an increasing need to move the dipoles even further away from the rear walls due to an excitation of room/boundary at 140 Hz.

It may have been due to my hurried construction but I could not achieve stability with the subsonic stage and had greater success with the circuit below, which I modelled on my own PC

I did find that I much preferred (on my dipoles) no

subsonic filter at all. You say that you feel it adds to the subjective speed at LF. I must confess I cannot detect this. However, for those using vinyl it will be necessary to prevent excessive cone movement.

Yes, without the filter there is tremendous presence of low frequency energy which is readily felt, particularly on organ and bass synthesiser.

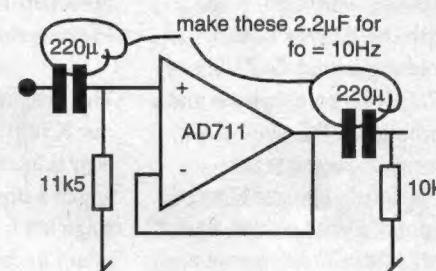
Hope this is of interest to you.

**David Huckle**  
**Cambridge.**

We're always glad to hear of people achieving success with interesting and advanced acoustic techniques beyond the understanding of the general hi-fi business. Proves how strong DIY can be.

I never encountered instability in the crossover, even when tuning in outrageous peaks, but layout and power supply decoupling (especially) do need to be attended to carefully.

Cone excursion is a problem with a dipole trying to produce high level subsonics and for safety, as well as for LP warps, I gravitated toward using a second order high pass filter at 20Hz, forsaking the delights of experiencing structural re-assembly of the



brickwork around the listening room.

Your circuit comprises two passive high pass sections with the op. amp. acting as a non-inverting stage between them. The right capacitor value is 2.2μF for a 10Hz turnover frequency, not 220μF. **NK**

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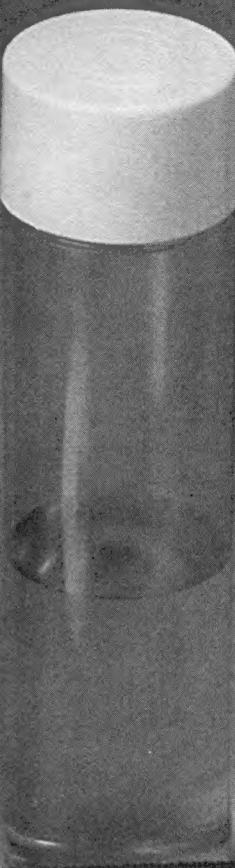
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